ORIGINAL ARTICLE

Effectiveness of the hands-free technique in reducing operating theatre injuries

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Background: Operating theatre personnel are at increased risk for transmission of blood borne pathogens when passing sharp instruments. The hands-free technique, whereby a tray or other means are used to eliminate simultaneous handling of sharp instruments, has been recommended.
Aims: To prospectively evaluate the effectiveness of the hands-free technique in reducing the incidence of percutaneous injuries, contaminations, and glove tears arising from handling sharp instruments.
Methods: For each of 3765 operations carried out in main and surgical day care operating theatres in a large urban hospital, over six months, circulating nurses recorded the proportion of use of the hands-free technique during each operation, as well as other features of the operation. The hands-free technique, considered to be used when 75% or more of the passes in an operation were done in this way, was used in 42% of operations. The relative rate of incidents (percutaneous injuries, contaminations, and glove tears) in operations where the hands-free technique was used and not used, with adjustment via multiple logistic regression for the different risk profiles of the two sets of operations, was calculated.
Results: A total of 143 incidents (40 percutaneous injuries, 51 contaminations, and 52 glove tears) were reported. In operations with greater than 100 ml blood loss, the incident rate was 4% (18/486) when the hands-free technique was used and 10% (90/880) when it was not, approximately 60% less. When adjusted for differences in type and duration of surgery, emergency status, noisiness, time of day, and number present for 75% of the operation, the reduction in the rate was 59% (95% CI 23% to 72%). In operations with less than 100 ml blood loss, the corresponding rates were 1.4% (15/1051) when the hands-free technique was used and 1.5% (19/1259) when it was not used. Adjustment for differences in risk factors did not alter the difference.
Conclusions: Although not effective in all operations, use of the hands-free technique was effective in operations with more substantial blood loss.

Operating theatre personnel, especially those directly involved in surgical procedures, are exposed to large quantities of blood, bloody body fluid, and other types of biological material such as bone. Numerous pathogens can be transmitted by exposure to these materials. Of most current concern are the hepatitis B (HBV), hepatitis C (HCV), and human immunodeficiency (HIV) viruses.

The operating theatre is also the hospital environment with the greatest concentration of sharp instruments.[1] Thus, the risk of percutaneous injuries from contaminated sharp objects, which can lead to blood borne disease transmission, is enhanced.[2–4]

Operating theatre policies and practices to lessen surgical risk have been proposed. Measures include redesigned instruments,[5] use of blunted suture needles for tissue below the skin,[6 7] work practices,[8] double or more gloves,[9 10] and in some countries, prohibiting HBeAg positive and HIV positive surgeons from carrying out exposure prone procedures.[11]

The hands-free technique for transferring sharp instruments is a work practice which has been suggested as a means of reducing the risk of such contamination.[12] It consists of the indirect transfer of instruments between surgeon(s) and other scrubbed personnel so that only one person touches the same sharp item at any time. Items are usually placed in a designated neutral or safe zone, which can be a section of the surgical field or a container, from where they can be retrieved.

Although the hands-free technique as a means of reducing risk in the operating theatre makes intuitive sense, it has not been evaluated. The primary goal of this study was to determine whether use of the hands-free technique during surgery was associated with a decreased rate of percutaneous injuries, contaminations, and glove tears.

METHODS

The study was conducted from 30 October 1995 to 15 April 1996 in a 300 bed private teaching hospital of a large city in the United States where use of the hands-free technique was hospital policy.

Operations and personnel included

Eligible operations were those performed in same day surgery operating theatres during weekdays and in the main operating theatres, 24 hours per day, seven days a week, with a full time circulating nurse present. Personnel considered at risk were all physicians, nurses, technicians, physicians' assistants, residents, and students who provided direct surgical care to the

Definitions

- A percutaneous injury is a puncture or laceration of the skin by a needle or other pointed instrument or object.[13] An apparent wound would be a confirmation, as would a pricking/stabbing sensation, not necessarily confirmed visually. Blood does not have to be present at the injury site.
- A cutaneous contamination occurs when blood or body fluid comes into contact with intact or non-intact skin (intact or non-intact).[14] A mucous membrane contamination occurs when blood or body fluid contacts mucous membrane, usually that lining the eyes, nose, or mouth.
- A glove tear is a perforation of a glove.

Table 1 Numbers of opreations, event rates, and use of hands-free technique overall and in various categories of surgery

	Number of operations	Number (%) of events*	Use (%) of hands-free technique
	687	8 (1.2%)	100%
	825	25 (3.0%)	75%
	1311	81 (6.2%)	50%
	458	8 (3.9%)	25%
	274	11 (4.0%)	0%
Overall			
Number	3765	143 (3.8%)	(42.0%)
Surgical specialty			
General	992	33 (3.3%)	(48.0%)
Other	975	20 (2.1%)	(48.0%)
Orthopaedic	1156	14 (1.2%)	(42.0%)
Cardiothoracic and cerebrovascular	639	77 (12.1%)	(22.0%)
Number of personnel in operating theatre			
1–5	2271	47 (2.1%)	(47.0%)
More than 5	1494	97 (6.5%)	(34.0%)
Duration of surgery			
1 hour or less	1499	7 (0.5%)	(47.0%)
1–2 hours	1261	37 (2.9%)	(45.0%)
More than 2 hours	995	100 (10.1%)	(30.0%)
Blood loss			
100 ml or less	2350	34 (1.4%)	(46.0%)
Greater than 100 ml	1391	109 (7.8%)	(36.0%)
Shift			
Days	2989	126 (4.2%)	(45.0%)
Evenings/nights	776	18 (2.3%)	(31.0%)
Emergency			
Yes	352	4 (3.9%)	(32.0%)
No	3334	127 (3.8%)	(43.0%)
Noise level (judged by circulating nurse)			
Quiet	1597	58 (3.6%)	(45.0%)
Noisier	2032	83 (4.1%)	(39.0%)

*All reported percutaneous injuries, contaminations, and glove tears were used. There were 144 events but the proportion of hands-free use was recorded for only 143.

patient; anaesthetists or others providing anaesthesia care, were excluded.

Data collection

After informally consulting (unstructured interview) scrub personnel at the end of each operation, the circulating nurse recorded an assessment[15] of the extent to which the hands-free technique was used, according to the following categories: none of the time, approximately 25%, 50%, 75%, or 100% of the time using a standardised two page questionnaire. She also recorded the type and length of operation, the amount of blood loss, the time of day, noise levels during surgery (subjective assessment), the number of people present for at least 75% of the operation, and whether it was an emergency procedure. More detailed information for each incident that occurred, which was either a percutaneous injury, a contamination, or a glove tear, was also recorded by the same nurse. The questionnaire can be viewed on the *OEM* website (www.occenvmed.com).

Reliability study

In 68 operations, occurring over an eight week period and including most types of surgery, the proportion of hands-free passes was rated independently by the principal investigator (BS) in order to assess the reliability of the circulating nurses' observations. A "substantial" inter-rater agreement of $\kappa = 0.72$ (95% CI 0.54 to 0.90) was found.[16]

Data analysis

The analyses were based on all operations for which there was an answer to the question, "Was the hands-free technique used?"

For the purposes of the analysis the hands-free variable was redefined as a "yes/no" variable. Those operations in which the hands-free technique was categorised at "75% of the time" or "100% of the time" were considered to have been performed using the hands-free technique. Those operations where the proportion of passes was categorised as "0%", "25%", or "50% of the time", were considered not to have been performed using the hands-free technique.

For the first set of analyses, all injuries, contaminations, and glove tears were considered indicators of overall safety and part of the accident continuum, and so were grouped together as "incidents".

To test a more specific effect of passing and handling sharp instruments, a second set of analyses were also carried out where the definition of an incident was limited to all glove tears and those injuries or contaminations specifically associated with handling and passing sharp items. (The questionnaire did not allow identification of glove tears related to handling and passing sharps.)

Six variables (table 1) previously reported to have a direct bearing on the risk of an incident[17–22] and another (noise), with the potential to confound the relation between hands-free use and the rate of incidents, were included in the analysis. Noise has not previously been associated with the risk of an incident, but has been found to be associated with hearing and short term memory loss.[23 24] Furthermore, analyses were carried out to assess whether the association between use of the hands-free technique and risk of incidents, was equally strong in all strata of the categories defined by blood loss, length of surgery, and type of surgery.

For these purposes, operations were grouped into categories (in order to have approximately equal numbers in the categories and to provide for more homogeneous risk profiles): orthopaedic, general, cardiothoracic and cerebrovascular (CVT) operations, and "other" operations (in which types such as plastic, gynaecology, ENT, and urology were combined). Duration of surgery was divided into three categories: 1 hour or less, 1–2 hours, and greater than 2 hours. Blood loss was

Table 2 Event rates in operations where the hands-free technique was used and was not used, overall and in relation to the amount of blood loss

Subgroup	Hands-free technique	Event rate	Crude rate ratio	Adjusted* rate ratio (95% CI)
Overall	Used	2.1% (33/11545)	0.41 (0.30 to 0.60)	
	Not used	5.1% (110/2153)	1.0 (reference)	
Blood loss				
<100 ml	Used	1.4% (15/1051)	0.95	0.99 (0.49 to 1.98)
	Not used	1.5% (19/1254)	1.0	
>100 ml	Used	3.7% (18/486)	0.34	0.41 (0.23 to 0.72)
	Not used	10.0% (90/880)	1.0	

*Adjusted for type of surgery, emergency status, duration of operation, noise, shift, and number of personnel.

dichotomised as less than or more than 100 ml. Noise levels were divided into "quiet and normal" versus "loud". Shifts were divided into day versus evening and night. The number of personnel present at least 75% of the time was dichotomised into 1–5 versus 6 or more. Operations were also classified as emergency or non-emergency.

As the frequency of incidents was low, relative risks of an incident, when the hands-free technique was and was not used were estimated using odds ratios (OR). To account for the considerable variation in risk according to other features of the operation, and to adjust for the different risk profiles of operations in which the hands-free technique was and was not used, unconditional logistic regression was utilised to estimate adjusted risk ratios (RR) and to produce 95% confidence intervals (CI).

All measured risk factors were included in the regression model. The three potential effect modifiers—blood loss, type of surgery, and duration of surgery—were included and retained if, when comparing the log likelihoods of models with and without the terms, the p value associated with the likelihood ratio was less than 0.10.[25]

RESULTS

There were 5388 eligible operations in the five and a half month time frame, but information on whether the hands-free technique was used was not recorded for 1623 (30%) operations occurring during this period. The main reasons questionnaires were not completed were that study personnel forgot or were too busy; or shifts changed so that the circulating nurse who began observing the operation was replaced before it had finished. The remaining 3765 (70%) eligible operations (with an answer to the question "Was the hands-free technique used?") were retained in the study (table 1).

The overall questionnaire completion rate was 70%. It was lowest for emergency operations (51%), non-day shift operations (60%), CVT operations (61%), and those operations occurring in December (62%) and during the last month of the study (61%).

Despite hospital policy, there was a wide range in use of the hands-free technique. The percentages of operations in the five categories of decreasing hands-free technique use ("used in all passes" to "not used at all") were 19%, 23%, 37%, 13%, and 8%, respectively. We grouped together the highest and second highest use categories (used in 100% of passes and 75% of passes), so that 42% (19+23) of operations were reclassified in what we termed the "hands-free used" category. We grouped the remaining three lower use categories to yield the 58% (37+13+8) of operations in what we termed the "hands-free not used" category.

As shown in the right hand column of table 1, use of the hands-free technique was less common in CVT surgery, during emergency non-day surgery, when blood loss was greater than 100 ml, when five or more persons were present, and during operations lasting more than two hours.

Outcome

All percutaneous injuries, contaminations, and glove tears that occurred resulted in an overall rate of 3.8% (40 percutaneous injuries, 51 contaminations, and 52 glove tears).

As table 2 shows, the incident rates in the operations where the hands-free technique was and was not used, were 2.1% and 5.1%, respectively, producing a rate ratio of 0.41.

Table 2 also shows the rate ratios for operations with less than and greater than 100 ml blood loss. The incident rates for operations with less than 100 ml blood loss were very similar: 1.4% when the hands-free technique was used and 1.5% when it was not. However, in those operations with more than 100 ml blood loss, the rates were 3.7% and 10%; the adjusted rate ratio was 0.41 (0.23 to 0.72), which corresponds to almost 60% reduction in risk.

The second analyses, considering only the restricted number of incidents (all glove tears and only injuries and contaminations more directly related to passing sharp instruments), found a similar pattern. The adjusted rate ratio was 1.49 (95% CI 0.68 to 3.31) in the operations with less than 100 ml blood loss, but 0.43 (95% CI 0.21 to 0.86) when blood loss was greater than 100 ml.

DISCUSSION

The goal of this study was to assess the impact of a recommended surgical work practice, the hands-free technique, on the rate of injuries, contaminations, and glove tears. We found that when blood loss during surgery was greater than 100 ml, use of the hands-free technique was associated with a decrease of 60% in event rates.

The present study has some limitations. It relied on circulating nurses to provide information on risk factors as well as use of the hands-free technique, at the end of each operation, while incidents, primarily self reported, arose at any time during an operation. In order to include as many eligible operations and incidents as possible, methods to maintain surgical personnel's interest, promote the study, and encourage reporting, such as weekly raffles, were used. These incentives were not linked to specific results. To lessen the likelihood that the occurrence of an incident would affect the estimate of hands-free use, quantification of use was made by more than one person; circulating nurses consulted with scrub personnel about proportion of use so that input from personnel closer to the surgical field would increase accuracy. In addition, the reliability study, based on 68 operations included in this study, found a high inter-rater agreement on hands-free use.

Another possible limitation of this study may be the uncontrolled confounding from the inability to measure individual characteristics such as age and previous experience of individual surgical team members or the experience of the surgical team as a whole. Although this is difficult to assess, in a previous operating theatre study, surgeons with 10 years or more experience were not found to have a decreased risk of

Main messages

- Operating theatre personnel are at risk of becoming infected with HCV, HBV, and HIV.
- Infected operating theatre personnel may infect surgical patients.
- It is essential that injuries and contaminations be decreased as much as possible during surgery.
- The hands-free technique, a means of standardising the handling of sharp instruments during surgery, may be most effective in operations with more substantial blood loss.

Policy implications

- Surgical personnel may be required (mandated) to decrease their occupational risk of contracting blood borne infections by using all methods shown to be effective.
- The hands-free technique is a means of standardising the handling of sharp instruments during surgery; standardisation in the handling of sharp instruments is an additional means of decreasing the risk of occupational exposure.

percutaneous injury when compared to surgeons with fewer than 10 years experience.[26]

An ideal but difficult study to carry out in practice would be to use a randomised trial to assess the effectiveness of the hands-free technique.

Despite recommendations from professional bodies,[27–29] the hands-free technique is not widely used. The reasons for this can only be speculated on. Some surgeons who did not use the hands-free technique during this study, commented that picking up sharp instruments from a field or basin would make them remove their eyes from the surgical site for brief moments or might increase the length of surgery. Others, who used the hands-free technique, did not perceive any deterioration in technique or overall patient care, or an increase in time spent carrying out procedures.

The additional hazard of blood borne disease transmission to patients, from infected operating theatre personnel at risk of incidents related to the transfer of sharp instruments, may increase the pressure to use the hands-free technique, especially as there are increasing numbers of reports of intraoperative transmission of blood borne pathogens to patients.[30–36] Insofar as use of the hands-free technique reduces the number of operating theatre accidents during which a surgeon or other personnel could potentially contaminate a patient, it could be used as another measure to make surgery safer.

The assumption underlying hands-free technique use, goes beyond it simply being a method of passing sharps indirectly; it is, in fact, part of a system of regularising operating theatre work practices by establishing a common routine, among a diverse group of skilled workers, who may or may not regularly work together.

Conclusions

The results of our study should apply to most hospitals in North America. The privately funded teaching hospital in which the study took place accepted uninsured patients and was located near the downtown core of a large American city. Many types of routine and complex surgery were carried out in this facility and the majority of surgeons carrying out surgery there worked in more than one facility.

Furthermore, as the mix of operations and having same day surgery, as well as operating theatres open 24 hours is typical, this study lends weight to recommendations made by various professional bodies that the hands-free technique should be employed as a safety measure.

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The questionnaire can be viewed on the *OEM* website (www.occenvmed.com)

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